**Title: Measurement Menagerie**

**Brief Overview:**

Students will learn how to apply knowledge of area, proportions, and scale drawing to real-world situations. In the assessment, they will use this knowledge to plan the layout of a small town business district.

**Link to Standards:**

- **Problem Solving** Students will write the appropriate proportion and solve the resulting equation. Students will be able to use various strategies to solve problems.
- **Communication** Students will demonstrate the use of mathematical terminology in reading and writing concerning problems applicable to a real-life situation.
- **Reasoning** Students will demonstrate the ability to reason mathematically. They will gather information, apply concepts, and justify arguments.
- **Connections** Students will demonstrate the ability to apply measurement concepts to real-life application.
- **Number & Number Relationships** Students will apply proportions to scale drawings.
- **Algebra** Students will solve simple equations.
- **Statistics** Students will organize and display data in a table. The students will use data analysis when justifying a real-life scenario.
- **Geometry/ Measurement** Students will determine the area of a polygon by partitioning, and apply the concept of perimeter to the given polygons. The students will select the appropriate unit of measurement and apply this idea to a real-life task.

**Grade/Level:**

Grades 6-8

**Duration/Length:**

This learning unit, including assessment, will take 4 days. The activities may take longer than anticipated depending on class duration and student's prior knowledge.

**Prerequisite Knowledge:**

Students should have working knowledge of the following skills:

- Calculating area of rectangles
- Calculating perimeter of polygons
- Solving proportions
- Measuring line segments

## Objectives:

Students will:

- gather, interpret, and apply information from a scale drawing.
- apply proportions to scale drawings.
- use map scales to set up proportional equations.
- construct a scale drawing.
- calculate the area of triangles and trapezoids.
- apply geometric concepts to maximize the use of an area.
- determine the dimensions of a rectangle which maximizes the use of a polygonal region.

## Materials/Resources/Printed Materials:

- Rulers
- Calculators
- Graph paper
- Scissors
- Activity sheets

## Development/Procedures:

### Day 1: Scale Drawing

- Model with students how to set up a proportion using a scale. Stress to the students the importance of labeling and matching units.

- Practice scaling various objects onto a grid using graph paper.

### Day 2: Application of Scale Drawing

- Assign Activity 1 from the worksheets/resources section. Students can work either individually or in small cooperative groups of 2 or 3 students.

### Day 3: Area of Triangles and Trapezoids

- Develop the formula for finding the area of a triangle. See Teacher Directions in the worksheets/resources section.

- Assign Activity 2. Students should work individually.

- Assign students to groups of 4. Give each group a copy of Activity 3. Compare group data with class data and discuss methods of solution.

### Days 4 and 5: Assessment Activity

- Assign the City Planning Assessment Task from the worksheets/resources section. Students should work individually on this assessment.

## Evaluation:

City Planning, a performace-based assessment task, including the teacher directions and a scoring key, is included in the worksheets/resources section. This assessment asks the students to determine the dimensions of the largest rectangle that will fit in a predetermined region. The students are required to draw these buildings on the map of their town's business district.

**Extension/Follow Up:**

1. Students will calculate the remaining area not used by the building and not required by zoning laws.

2. Students will complete the City Planning Assessment task. Instead of rectangular buildings, have the students construct circular buildings or other polygonal shaped buildings.

**Authors:**


Donald Carey
St. Francis de Sales School
Wicomico County, MD

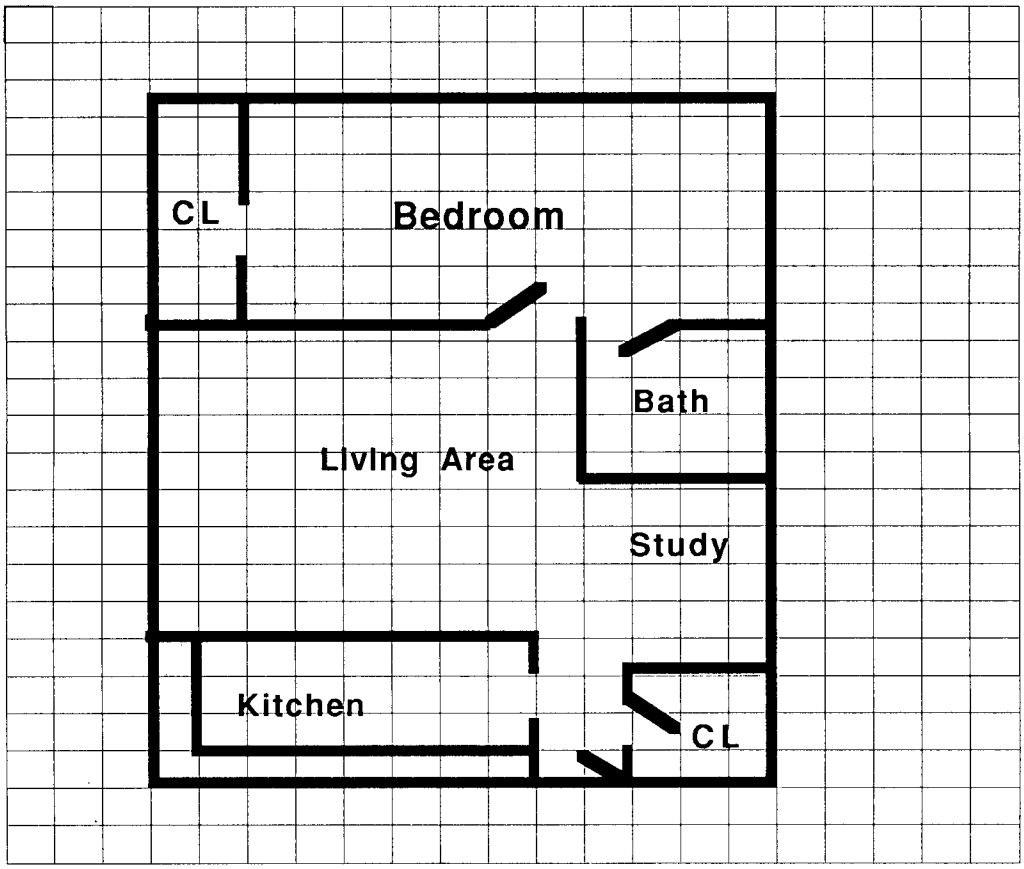
Susan Higley
Cherry Hill Middle School
Cecil County, MD

Leslie Schroeck
Mattawoman Middle School
Charles County, MD

Heather Thompson
Fallston Middle School
Harford County, MD

## Activity 1
## A Place of Your Own

You are going away to college and will be living in a student apartment. The floor plan for your apartment is given. You will use this floor plan to answer the questions that follow.




Scale: 2 blocks = 3 ft.

1) Find the dimensions of each room in the apartment. Set up a proportion **for each** dimension. Use the table to organize your work.

| Room | Proportions | Dimensions |
|---|---|---|
| kitchen | | |
| living area | | |
| study | | |
| bathroom | | |
| bedroom | | |

2) You have the following furniture to move into your apartment. Using the given dimensions draw in each piece according to the scale, 2 blocks = 3 feet.

A.

| Piece of furniture | **Dimensions** |
|---|---|
| kitchen table | **36 in by 54 in** |
| **couch** | **6 ft by 3 ft** |
| **entertainment center** | **54 in by 36 in** |
| **desk** | **36 in by 18 in** |
| **bed** | **3 ft by 6 ft** |

B. Explain in words how you determined the scale size for each piece.

3) List other pieces you would add to make your apartment uniquely you.

## Key to Activity 1

1)

| Room | Proportions | Dimensions |
|---|---|---|
| Kitchen | 2/3=8/x  2/3=4/x | **12 ft by 6 ft** |
| Living area | 2/3=8.5/x  2/3=9/x | **12.75 ft by 13.5 ft** |
| Study | 2/3=5/x  2/3=4/x | **7.5 ft by 6 ft** |
| **Bathroom** | 2/3=4/x  2/3=4/x | **6 ft by 6 ft** |
| **Bedroom** | 2/3=6/x  2/3=11/x | **9 ft by 16.5 ft** |

2a The dimensions for the furniture are below. These may be placed on the floor plan as the students desire.

| Furniture | Scale dimensions |
|---|---|
| kitchen table | **2 bk. by 3 bk.** |
| couch | **4 bk. by 2 bk.** |
| entertainment center | **3 bk. by 2 bk.** |
| desk | **2 bk. by 1 bk.** |
| bed | **2 bk. by 4 bk.** |

2b) Individual teacher discretion.

3) Individual teacher discretion.

# Teacher Directions
# Using a Formula for Finding the Areas of Triangles and Trapezoids

1. Development of the concept of the area of a triangle can be defined by the student in cooperative groups as a problem solving task.

   Given: The area of a rectangle is defined as the length multiplied by the width.

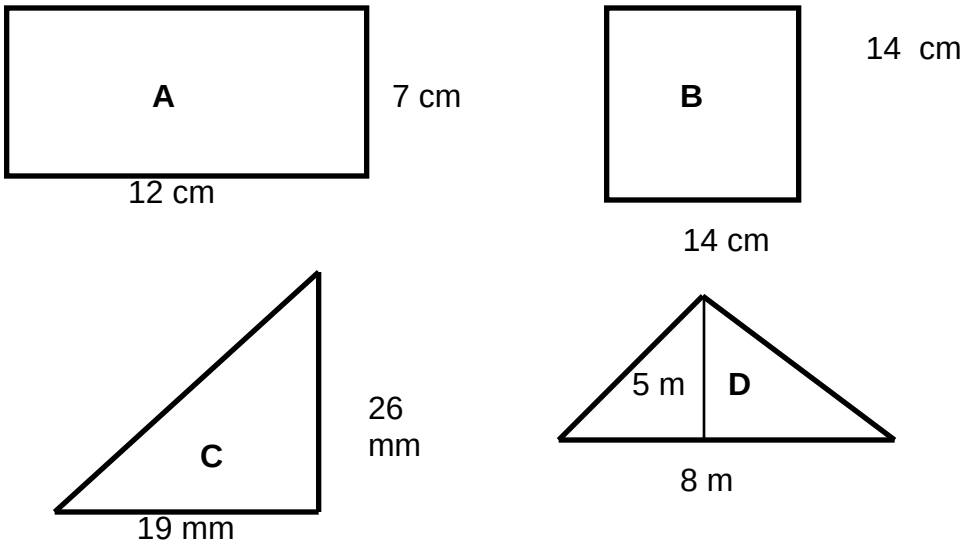
   Materials: Rulers
   Activity 2 worksheets

   Activity: Distribute the prepared Activity 2 worksheets.

   Instruct the students to use rectangle A to form 2 triangles. Direct the students to modify A = l x w formula to create the formula to find the area of a triangle. Then apply this process to rectangle B. Apply the formula in finding the areas of triangles C and D. Have the students discuss and evaluate their findings.

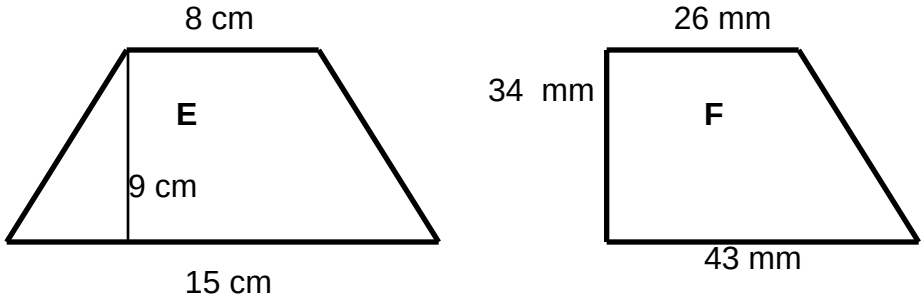
# Activity 2
# Tricky Triangles and Toughy Trapezoids

1) Follow teacher directions. Remember the formula for the area of a rectangle is A= L x W



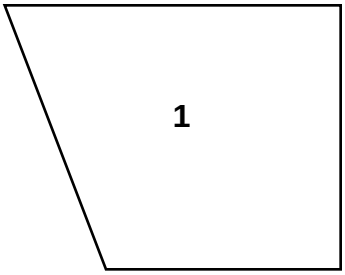

2) Write the formula you developed for triangles. How does this formula relate to rectangles?

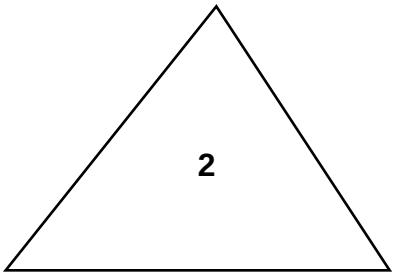
3) The formula for finding the area of a trapezoid is A = 1/2 ($b_1$ + $b_2$) h. Use this formula to find the area of the following trapezoids.

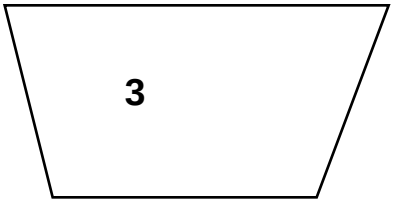


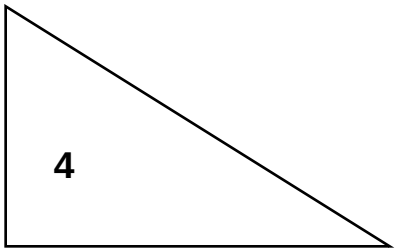
## Activity 3
## Making it Fit

1. Use a ruler to measure the dimensions needed to find the area of each polygon below. Use centimeters and round your measurement to the nearest tenth of a centimeter. Then find the area and record your data in the chart.



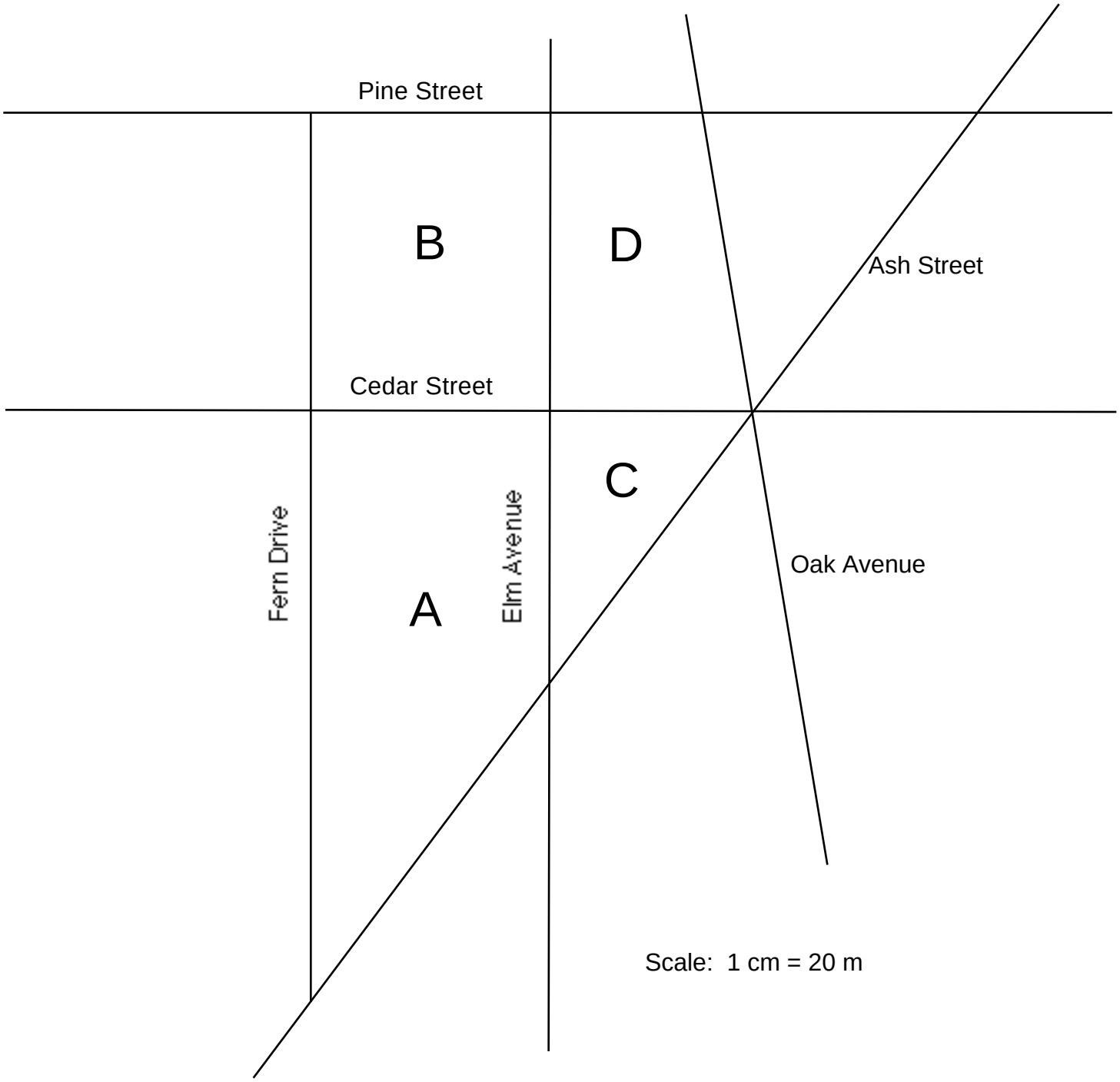

2. Now, you need to draw a rectangle in each of the polygons. Your rectangle should cover as much of the area of the polygon as possible.

3. Using your ruler, measure the length and width of your rectangles. Find the area of each rectangle and record your data in the chart.

| Polygon | Area of Polygon | Area of Rectangle |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |

# City Planning
# Assessment Task

You are a developer. The town council has accepted your bid to construct four buildings. The town commissioners have agreed with your proposal that the four buildings are to be rectangular, since this will maximize their efficiency. Below is a map of the town's business district. The four buildings you will construct will be built on plots **A, B, C,** and **D**.


Pine Street
B
D
Ash Street
Cedar Street
C
Fern Drive
Elm Avenue
A
Oak Avenue
Scale: 1 cm = 20 m

**1a.** Choose a suitable name for this city. _____

**1b.** What is the scale of the map? _____

**2.** Justify, in words, why a rectangular building would provide maximum efficiency for this particular case.

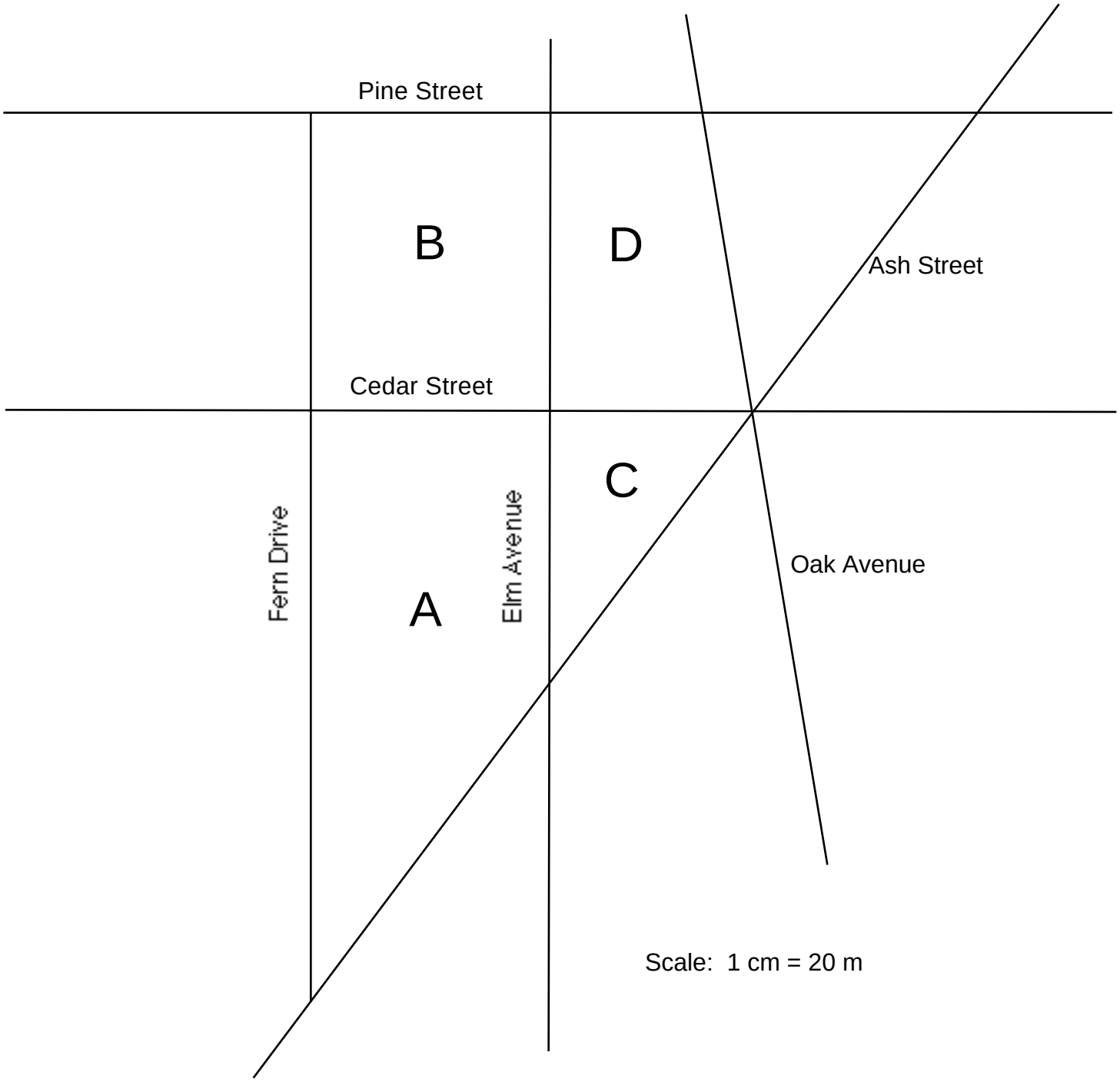
Next, you will determine the dimensions, area, and location for each of the four buildings and construct your buildings.

**3a.** Using information from the map, calculate the area for each plot.

| Plot | Area |
|---|---|
| **A** | |
| **B** | |
| **C** | |
| **D** | |

**3b.** Explain the procedure(s) used to find these areas.

**4a.** Your town's building code requires that all buildings be at least 10 m from the street. Using the map below, determine the dimensions of the rectangular building that maximizes the use of the plot's area while satisfying this building code. Draw the buildings to scale on the map. Label the buildings **a, b, c,** and **d**.




**4b.** On your map, label the building with the largest area as the courthouse.

**4c.** Justify, in words, why you chose that building.

**5.** Complete the following table.

| Plot | Area | Area of the Building | Remaining Area |
|---|---|---|---|
| **A** | | | |
| **B** | | | |
| **C** | | | |
| **D** | | | |

**6.** Which plot allows for the best use of the area with the least amount of remaining area. Justify your answer, in words.

**7.** Complete the following table.

| Plot | Perimeter of Plot | Perimeter of Building |
|---|---|---|
| **A** | | |
| **B** | | |
| **C** | | |
| **D** | | |

**8.** I found this activity to be

| Very Difficult | Somewhat Difficult | Average | Pretty Easy | Extremely Easy |
|---|---|---|---|---|

# City Planning
# Assessment Task
# Teacher Directions, Rubrics, and Scoring Keys

When scoring this task, use the following rubrics.

## Rubric A

| | |
|---|---|
| **2** | -Response is complete and functionally accurate<br>-Uses appropriate formulas and displays working knowledge of concepts<br>-Correct mathematical terminology is used to justify responses<br>-Charts are accurate and complete |
| **1** | -Response is nearly complete and contains aspects of functional accuracy<br>-Has either used the formula or displayed working knowledge of concepts<br>-General knowledge of mathematical terminology is communicated to justify responses<br>-Charts are partially accurate and complete |
| **0** | -Response lacks completeness and functional accuracy<br>-Formulas need to be displayed and developed<br>-Communication of mathematical concepts needs improvement<br>-Charts lack accuracy and completeness |

## Rubric B

| | |
|---|---|
| **1** | Correct response |
| **0** | Incorrect Response |

## Rubric C

This response is not scored.

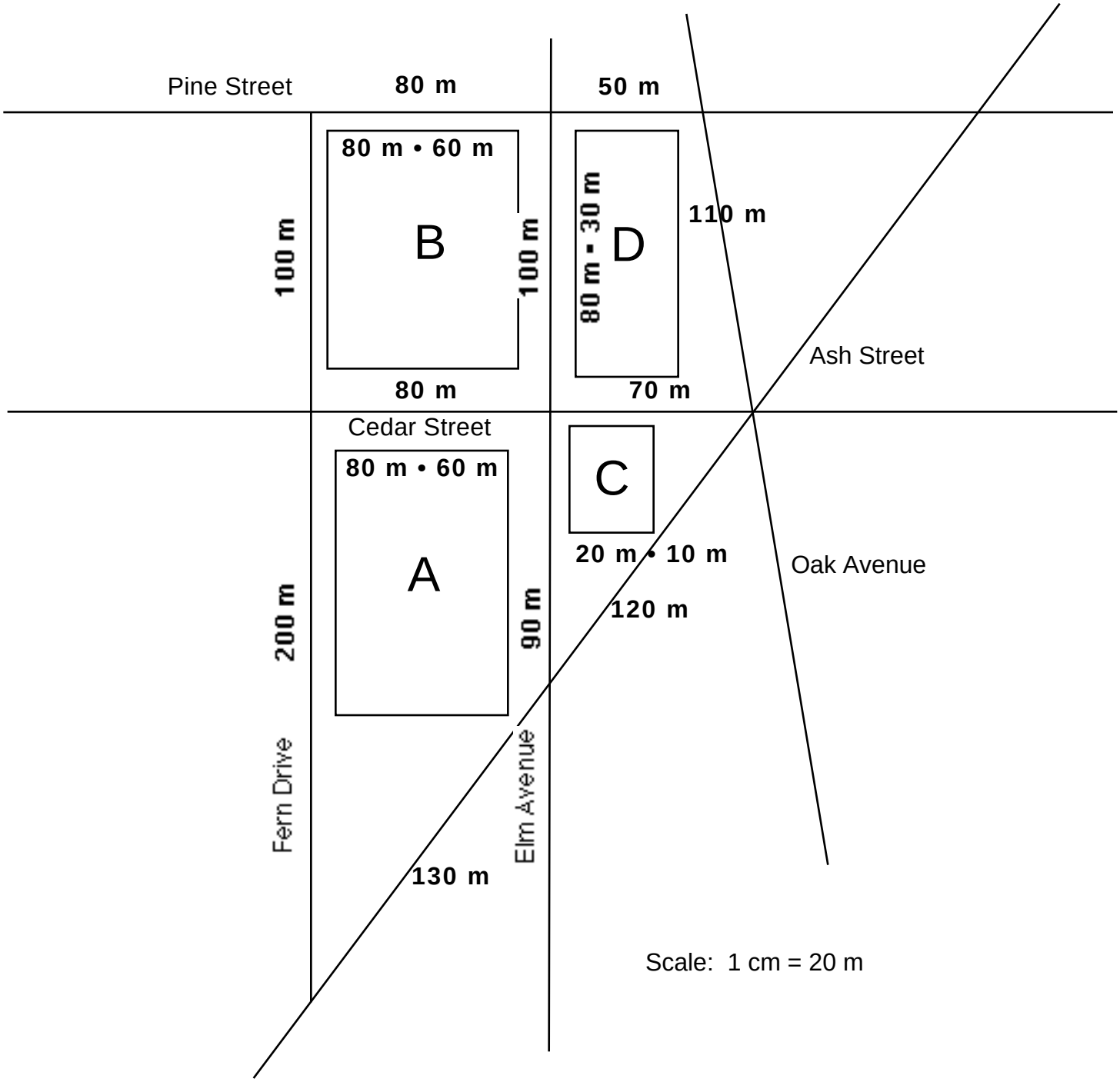
| Activity | Rubric |
|---|---|
| 1a | C |
| 1b | B |
| 2 | A |
| 3a | A |
| 3b | A |
| 4a | A |

| Activity | Rubric |
|---|---|
| 4b | B |
| 5 | A |
| 6 | A |
| 7 | B |
| 8 | C |

**Sample Key for Activity 3a**

| Plot | Area |
|---|---|
| **A** | 11,600 $m^2$ |
| **B** | 8,000 $m^2$ |
| **C** | 3150 $m^2$ |
| **D** | 6000 $m^2$ |

# Sample Key to Activity 4a



## Sample Key for Activity 5

| Plot | Area | Area of the Building | Remaining Area |
|---|---|---|---|
| **A** | 11,600 $m^2$ | 4800 $m^2$ | 6800 $m^2$ |
| **B** | 8,000 $m^2$ | 4800 $m^2$ | 2600 $m^2$ |
| **C** | 3150 $m^2$ | 2000 $m^2$ | 2950 $m^2$ |
| **D** | 6000 $m^2$ | 2400 $m^2$ | 3300 $m^2$ |

## Sample Key for Activity 7

| Plot | Perimeter of Plot | Perimeter of Building |
|---|---|---|
| **A** | 500 m | 280 m |
| **B** | 360 m | 280 m |
| **C** | 280 m | 60 m |
| **D** | 330 m | 220 m |